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FUNGI INFLUENTIAL IN HUMAN DISEASE*

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I. *Introduction*

For a thorough knowledge of fungi, a basic course in botany and one in mycology are necessary. However, it should be possible to secure a workable acquaintaince with the fungi influential in disease with a little concentration. I am going to mention some 30 fungi (pathogenic and saprophytic) which you are most apt to encounter in your work. These I have organized into an exhibit also.

Firstly, I intend to discuss the fungi morphologically—some technicality will be involved of necessity and as a stimulus to your curiosity of the *how* of these organisms. Secondly, I wish to form a clinical classification so that you may know what to expect from the type of specimen presented you. Thirdly, I shall mention incidence, geographic distribution, and intermediate hosts—plants and animals. Finally, I am going into technic after you are somewhat acquainted with the names of the organisms I shall specify.

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II. *Morphological Classification*

The fungi can be segregated into five large groups based on morphology and delineated primarily on methods of sexual reproduction. Of course, in these more or less strictly parasitic forms with a good deal of host specificity, much degeneration and parthenogamy (or loss of true sexuality) has resulted. The nomenclature of this group has undergone much change, but I shall use the more familiar terms. The groups are in order of their advancement:

(A) Schizomyces (the bacteria)
  (1) Actinomycetales—bacterial size, no nuclei.

(B) Eumyces (true fungi)
  (2) Phycomycetales—coenocytic (multinucleate non-septate) mycelium, zygote, sporangium.
  (3) Ascomycetales—ascus containing spores resulting from sexual fusion, septate, uni- to multinucleate.
  (4) Basidiomycetales—distinguished by the basidium, clamp connections, binucleate hyphae.
  (5) Hyphomycetales (Fungi Imperfecti)—miscellaneous group with no sexual stage known.

(1) The *Actinomycetales* are really a group of higher bacteria closely related to the Mycobacteriales. There are aerobic and anaerobic forms, acid-fast and non-acid fast species. These organisms are of minute size (0.2-1.5 μ in diameter) with no nuclei and showing true branching and segmentation of cells into pseudospores. No sexual reproduction is present.

The anaerobic etiological agent of Actinomycosis (*Actinomyces Israeli* or *A. hominis*) forms a basal sediment or tiny balls along the sides of the vessel in broth, and small white circular colonies on agar. Diphtheroid elements are first formed in broth and later filamentous threads. In old brain broth cultures I have secured the production of small sulphur granules as in the host. The acid-fast pathogenic varieties resemble M. tuberculosis on culture. The aerobic saprophyte, A. gris colus, forms gray dusty colonies on agar and pellicles on broth, and has a distinctly musty odor.

(2) The *Phycomycetales* have cells of larger diameter than the bacteria and larger than most other fungi, i.e., up to 15 μ. The mycelium (or mass of fungus filaments) has true nuclei, but there are rarely cross walls resulting in a coenocytic condition (literally of many nuclei). This is a distinguishing feature. In the lower forms of this group there are two grossly different kinds of plants, male and female; whereas in the higher ones, and those concerning us, the difference is purely physiological (i.e., plus and minus strains). The common bread mold, *Rhizopus nigricans,* I will choose as my exemplary type. It may arise in your cultures as a contaminant from the air or skin. The colony grows very rapidly and is fragily fuzzy with tiny dots (sporangia) perceptible to the naked eye. Whenever a plus and minus strain are present, tips of approaching ends are cut off by a cell wall into multinucleate cells (gametangia). These fuse forming a zygospore in which nuclei also fuse giving a diploid condition (i.e., having the double number of chromosomes). A heavy-walled structure is formed which rests a while and is resistant to adverse environmental conditions. Later it germinates forming a sporangium up to 70 μ in diameter with spores 2-6 μ in diameter and peculiarly ridged. These sporangiospores have the haploid number of chromosomes and bear either the plus or minus sex potentialities. Similar sporangia are produced on mycelia from these reduction-division spores with the daughter spores naturally all of one sex. Another type of spore you may encounter is the chlamydospore or thick-walled asexual resting spore.

The only human pathogens belong to the genus *Mucor* and are very similar to the bread mold.

(3) The *Ascomycetales* contain a number of parasites of diverse morphological nature. However, in all there is produced an ascus by sexual reproduction or its counterpart. This is a roundish body containing usually eight uni-nucleated spores. The ascus was formed by the fusion of two haploid uninucleate cells (gametes). Somewhere in the production of the eight ascospores, reduction division has occurred so they are haploid again. In certain species more or fewer spores may be produced but all in the ascus. Another variation is the sprouting of the fused cell into ascogenous hyphae

(filaments of cells all diploid and binucleate) before the final production of a number of asci. This is merely a means of increasing the number of offspring from a single sexual fusion. Sometimes elaborate fruiting structures are produced, theca, containing an elaboration of asci and sterile hairs. Asexual spores are abundant in this group going under the name of chlamydospores, conidia, oidia, etc.

There are two large divisions in the Ascomycetes: (1) the yeast-like fungi, and (2) the filamentous moldlike type.

In the yeast type are such familiar reduced forms as *Saccharomyces cerevesiae* (the wine yeast) in which the colonial growth is made up of budding cells with some pseudomycelium (or elongate yeast loosely held together in a chain). At times (usually unfavorable for vegetative growth) four ascospores are formed in a single yeast cell parthenogamously. Some of the more primitive yeasts have true sexual reproduction.

"Monilia" albicans, of pathogenic significance, resembles the wine yeast but has completely lost its ability for sexual reproduction, i.e., no ascus is formed, so technically it is an imperfect fungus. Other yeasts remain purely budding—we have here some skin contaminants, the Cryptococci, and a rare but virulent pathogen commonly called *"Torula" histolytica*. On an agar slant the Cryptococci and "Torula" will be seen to grow on the surface of the agar only, whereas those with pseudomycelia ("Monilia" and Saccharomyces) send tree-like projections into the agar. These form white, pink or tan creamy, smooth or rough-surfaced colonies.

The organisms of Blastomycosis and Coccidioidal granuloma belong here too. They grow as yeasts in the host, but on artificial media eventually form white cottony growths. They have a sexual reproduction of the ascomycete type. Some rarer forms related to this group which I shall mention only, are Histoplasmosis (3 cases reported from the Mississippi valley of the U. S. and a few cases in the tropics); Rhinosporidiosis (few cases from the Mississippi valley); and Paracoccidiosis (Brazilian blastomycosis). If you have occasion to study these organisms there are recent publications concerning them.

From the moldlike Ascomycetes we may choose the genus *Aspergillus* as a type. The common saprophyte, *A. glaucus*, forms a green felty mass which later becomes yellow with the production of ascocarps. The distinguishing asexual spores are seen radiating in chains from a round-headed spore-bearing stalk. The mycelium is septate and each cell is uninucleate. Ascogenous hyphae arise after an inconspicuous fusion of two cells and eventually a number of asci are produced in heavy-walled ascocarps (perithecia). Only one species of the group has been proven pathogenic and it is rarely encountered (*A. fumigatus*), but the genus is important for its ubiquitous saprophytes. *Penicillium*, *Scopulariopsis* and *Cephalosporium* are closely associated types of mildly pathogenic or saprophytic capacities, with characteristic asexual spores.

(4) *Basidiomycetes.* The toadstool or field mushroom is the most familiar example of this group. If you remove the gills and examine one under the microscope you will note the little basidia, club-shaped bodies with usually four basidiospores attached by slender filaments. It is the characteristic end-result of a sexual fusion. The mushrooms do not concern us unless you have to examine a stomach contents and note toadstool structures in a case of poisoning (this is just an idea, I do not know that it is done). Basidiomycetes can also be recognized by clamp connections between cells in their filaments—and represent a degeneracy or sexual reproduction.

You should be able to recognize the smut fungi—very specialized and reduced basidiomycetes parasitic on corn and other grasses. They are to be considered in allergy of human beings and as contaminants on culture plates. The growth is yeast-like but distinctive. When a basidium is formed (in the plant host only) it differs from the mushroom type by being elongate and four celled with four basidiospores attached one to each cell. The wheat rust uredinospores are also allergens. They are difficult to culture but may be recognized on slides exposed for pollen counts.

(5) *Hyphomycetes.* This is a dumping ground for all of those fungi for which we know no sexual stage. They must be identified on the basis of cultural characteristics on standard media and on the basis of asexual spore forms. I shall merely list the several

pathogens and contaminants of concern to you and picture their morphological characteristics and colonial appearances.

(a) *Sporotrichum.* The etiological agent of Sporotrichosis forms a flat dry smoothly corrugated colony on Sabouraud's agar, of tan color, later becoming black. Conidia are abjointed all along the sides of the terminal cells and in old cultures numerous heavy-walled chlamydospores are produced causing the colony to become black.

(b) *Hormodendrum* has several species causing Chromoblastomycosis, and other species are common saprophytes. The growth may begin as a black yeasty colony which later becomes greenish black, a close felt-like mass; or the original growth may be thus. Elongate multi-budding yeastlike cells are found as well as mycelia with heavy-walled cells and various types of conidiophores.

(c) The *Trichophytoneae* are the organisms causing dermatophytosis, ringworm, etc. There is evidence that they are closely related to the Ascomycetes, but they themselves do not show sexual reproduction. A host of special asexual spores and structures characterize this group, such as: fuseaux, microspores or aleurospores, spirals, pectinate bodies, racquet mycelium, nodular organs and arthrospores or chlamydospores. White, yellow, red and purple colors are found in these felty colonies. They tend toward pleomorphism, i.e., on long culture most of them produce similar white fuzzy colonies with few spore forms present. This condition is usually irreversible and is associated with loss of pathogenicity.

Four genera are concerned and clinical history and colonial appearance are of primary importance in identification. *Achorian* (causing Favus) grows in the scalp and nails in immigrants from southern Europe. The colony is white and cerebriform. Two species of *Microsporum* involve principally the scalp. *M. Audouini* is found in human beings only and is a slowly growing white colony. *M. lanosum* also attacks cats and dogs and produces a deep yellow color in the medium and relatively rapidly growing white colonies. *Epidermophyton inguinale* usually begins in the groin and produces a greenish yellow dry colony. Two species of Trichophyton are especially important in athletes foot and nail involvement. *T. gyp-*

seum produces white fluffy or granular colonies, and *T. purpureum* a white colony with a purple color on the reverse side and in the medium.

(d) *Alternaria* is one of the most frequent contaminants and important in allergy (asthma, hay fever and eczema). Gray-black fuzzy colonies are characteristic and the yellow macroconidia with several heavy cross walls are diagnostic.

(e) Other saprophytes and allergens include *Fusarium, Chaetomium, Mycoderma, Trichoderma, "Oidium" lactis,* etc., of which I have pictured the spore types.

III. *Clinical Classification*

It may be helpful to know what fungi to expect in different clinical conditions and from the specimens submitted you. Fungi are aerobic growers with the exception of the organism causing Actinomycosis, and are weak parasites compared to the bacteria. For these reasons and the frequent ability to grow saprophytically in nature they are most often found on the skin.

Of the fungi growing superficially on the skin we may mention the organisms in erythrasma, tinea versicolor and the bottle bacillus (a yeast) found in dandruff and seborrheic eczema. These are readily seen in sodium hydroxide mounts of scales and are not easily cultured if at all. Their recognition is important in ruling out other clinical conditions, although it must be remembered that there may be cases of multiple etiology.

Fungi invading the skin more deeply include predominantly the Trichophytoneae which cause dermatophytosis (athletes foot) of the feet and hands, tinea cruris of the groin, tinea circinnata of the smooth skin of the body, and tinea capitis of the scalp. All of these may be recognized non-specifically in hydroxide preparations of the scales and hairs. I discussed specific localization in the previous section. These fungi cause severe sensitization in some individuals and extensive toxic rashes may develop in which no organisms are found. In such cases it is important to look for the focus containing fungi, usually on the feet. This is the one group of fungi which is highly contagious.

Another organism producing skin lesions somewhat resembling those of the Trichophytoneae is the yeastlike *"Monilia" albicans.* This has a predisposition for the interdigital spaces of the hands, the bases of the nails, the corners of the mouth, under the breasts and in the groin.

The organism of chromoblastomycosis grows slowly in the host, and persistently, forming huge granulomas, but does not become disseminated by the blood stream. Its heavy-walled spores may be recognized in scrapings and culture is usually successful.

Then there is a group of organisms which although they usually begin their growth on the skin, tend to produce deeper lesions and become systemic. These are truly dangerous diseases to the individual patient, but fortunately are infrequent and essentially noncontagious.

The organism of Sporotrichosis grows subcutaneously, spreads by the lymphatics and is most typically found on the hands and arms. It is difficult to find in smears the cigar-shaped spores and it grows slowly in culture requiring about 7 days. Therefore it is quite essential to get cultural material from uncontaminated unopened lesions.

Actinomycosis most frequently begins near the jaw. Sulphur granules (looking as their name implies) in the pus are diagnostic. Anaerobic culture on broth or agar is necessary for growth and the changed morphology (diphtheroid-like) must be recognized. The infection may also begin in the lungs or intestinal tract. The lesions progress through all tissues to the surface, eventually producing copious amounts of thick yellow foul-smelling pus. Other organisms such as white staphylococci and gram negative tiny bacilli are frequently associated with the actinomycete organism.

Blastomycosis and Coccidioidal granuloma resemble each other clinically, except that the latter progresses more rapidly and is more apt to be fatal. These two are usually initiated on the skin or in the lungs. In the exudates strictly budding cells of 5-20 μ with double-contoured walls may be recognized in Blastomycosis. In Coccidioidal granuloma the cells are solitary, of sizes 5-60 μ, the latter containing numerous endospores which are released by rupture of the parent cell.

The organism causing Torulosis, although much less frequent than the above and usually found in meningitis is occasionally in the lungs and on the skin secondarily. Its appearance in exudates is distinguished from the above in that you have strictly budding cells of 3-15 μ surrounded by a wide hyaline capsule and a lysed area outside of that. This is quite obvious in stained smears and in tissue sections. It loses the capsule on culture.

The milder "Monilia" when found in the lung or stool specimens has no capsule and pseudomycelial cells as well as budding yeasts. All of these yeasts respond fairly easily to culture on appropriate media.

In otomycoses we have species of *Aspergillus* or *Mucor*, and occasionally *Scopulariopsis* and *Actinomyces*.

In the lungs we may get pseudotuberculous conditions where are found acid-fast *Actinomyces*, Blastomycosis, Coccidioidal granuloma, *Aspergillus fumigatus* and rarely *Mucor*.

Also we must consider the fungi as allergic incitants, in asthma, eczema and hay fever. *Alternaria* is very common in the air and has been proven of seasonal significance in asthma. Other fungi imperfecti with large rough spores such as *Chactomium*, *Fusarium*, *Aspergillus*, smuts and rusts, etc., have been shown sensitizing by scratch tests with powdered extracts.

In the stool specimens you are very apt to encounter species of *Actinomyces* whose significance has not been investigated, but I have a feeling that they may be important in certain intestinal disturbances, especially colitis. Yeasts are also frequent, as is to be expected when so many people eat yeast for vitamin factors. They include Cryptococci, Saccharomyces, *"Oidium" lactis* and several species of *"Monilia"* including *M. albicans*. It has been said that the latter is found in 6-20% of normal stools. Nevertheless its identification is important. The yeasts have a great tendency to sensitize and I think that a number of sterile eczemas of the hands especially, may be related to growth of yeasts in the intestinal tract. Moniliids are scattered eczematous patches on the skin caused presumably by the growth of *M. albicans* throughout the alimentary canal. The organism is also regularly found in tropical sprue

although its presence is generally believed an after-effect rather than the cause. In this condition it is often called *M. psilosis.*

In meningitis it is necessary to eliminate *Torula histolytica* from the diagnosis.

A word of caution may be wise. The mere presence of a fungus does not indicate that it is the sole cause of a disease. Fungi are weak parasites and may be secondary invaders, e.g., *Monilia* in the lungs. So one should not overlook concomitant perhaps more serious infections such as tuberculosis, syphilis and cancer.

It is very important to make careful preliminary examinations of the host tissue for these organisms along with culture, as the fungi being slow growers are often suppressed by bacteria.

IV. *Incidence, Geographic Distribution, and Intermediate Hosts.*

In a year's culturing of miscellaneous specimens I worked out the incidence of fungus occurrence as shown in my exhibit—which may be of interest to you. I feel that too often in routine laboratories fungi are overlooked. In that collection *"Monilia" albicans* and *Actinomyces* spp. were relatively common, as well as the saprophytic *Aspergillus* and *Mucor.*

The geographical distribution of fungi must also be taken into account. For example, if you live in California, you must be on your toes for Coccidioidal granuloma which peculiarly is endemic (i.e., localized) to that region. We believe this is because of a natural saprophytic existence on a plant in that region, what we do not yet know. In agricultural communities, such as the middle west, we are more apt to get Sporotrichosis and Actinomyces, and less frequently Blastomycosis. In the east where immigrants from southern Europe are apt to frequent the clinics, we must look for the European blastomycosis, i.e., Torulosis; and Favus. In N. Y. the three commonest species that I have encountered in dermatophytosis are: *T. gypseum* of the smooth skin alone and generally feet and hands or rarely as little white superficial patches on the surfaces of the nails; *T. purpureum* of hands and feet and sometimes generalized with frequent and severe involvement of the nails; and *E. inguinale* of groin, feet and axillae. The relative incidence of *M. Audouini* and *M. lanosum* varies widely in different sections of the U. S.

A number of the pathogenic fungi apparently grow on plants more or less saprophytically: e.g., Sporotrichum on Barberry bushes and possibly the one on carnations may infect human beings; the Trichophytoneae are found on wet shower room wooden floors; others of these fungi grow on dung and in soil. Some of them occur naturally in animals; e.g., Blastomycosis and Actinomycosis in cattle, Sporotrichosis in horses, and *Microsporum lanosum* in cats and dogs. The belief that the anaerobic *Actinomyces Israeli* is contracted from chewing straw, etc., is now generally discredited. The frequent finding of these organisms in the tonsillar crypts is, however, significant.

V. *Technic*

In examination for fungi in specimens from scales and hairs, I use 30% KOH (10-30% has been recommended of either NaOH or KOH). The specimen is more or less macerated with a scalpel and needle, cover slip applied and gently warmed over a flame and set aside for 5-10 minutes. The host tissue tends to be dissolved but not the fungus. Microscopic examination under low and high power shows frank fungous filaments if they are present. I also note mosaic in my report as being significant (although there is some controversy over this point). Some say mosaic is a chemical deposit since it is intercellular, others say degenerate fungi. At least it is not always encountered, and when found in dry scaly lesions I recommend treatment for fungi. In hairs the fungus spores can be seen around or in the shaft. Air bubbles frequently confuse the initiate, but can be recognized by their clear center whereas fungus elements have a granular center.

If there is an exudate I make smears and do Gram staining. Most mature fungi are gram positive. If it is a sputum specimen an acid fast stain should be done for acid-fast Actinomycetes, and Aspergillus fumigatus as well as for tuberculosis. India ink can be used to show capsules if Torulosis is suspected. The sulphur granules of Actinomycosis are best found in KOH mounts, or if the pus is copious they may be seen with the naked eye in saline dilutions. The Gram-Weigert stain is commonly used for fungi in histological specimens, and I have told you how to differentiate the yeast parasites in these.

In taking specimens from the skin, one should cleanse the surface lightly with 70% alcohol and secure material from the edge of the lesion where the most active growth of the organism occurs. In athletes foot the roof of the vesicle should be planted rather than the exudate.

My standard medium for molds is Sabouraud's dextrose agar with tap water, 1.5% agar and pH 5.5. For yeasts Difco's Wort agar is preferable as it practically eliminates bacterial growth. For anaerobic Actinomyces 1% dextrose broth or 6% glycerine broth or agar are good. Anaerobic cultures in broth are made by warming and rapidly cooling the broth and covering after inoculation with sterile melted vaseline for ¼ inch or more. Examinations are made with sealed capillaries broken on the bottom of the culture tube. Material is stained by Grams. Anaerobic test tube slants can be made by putting KMnO4 and NaOH on the stopper, sealing with a rubber stopper and covering with paraffin or parowax paper.

Cultures for Trichophytoneae and Sporotrichum should be incubated at room temperature in semi-darkness, and kept for at least seven days. Cultures of Actinomyces and yeastlike fungi should be grown at incubator temperature.

I mount culture material of yeasts and molds in lacto-phenol and cotton blue. These slides are semi-permanent and may be kept indefinitely by putting paraffin around the edge of the cover slip.

It is a good idea to make thus a collection of permanent mounts of the commoner fungi for comparison. Permanent cultures may also be kept on test tubes. When the colony reaches the proper stage the stopper is moistened with formaldehyde and replaced in the tube for 48 hours. Then it may be covered directly with paraffin to prevent evaporation and shrinking of the agar, or the stopper may be replaced by a sterile rubber one which is also sealed with paraffin. Petriplate permanent cultures may also be made. When the colony is mature, a piece of filter paper moistened with formaldehyde is put in the upper part and the plate inverted for 24 hours. Then the paper is removed aseptically and a layer of cotton put between the sides of the 2 plates and warm paraffin poured over that.

To induce ascus formation, useful in the identification especially of yeasts, Gorodkowas agar or carrot plugs are good.

Stock cultures may be kept in the ice box and transferred about every three months. Do not seal the stoppers of these very aerobic organisms.

For exact diagnoses of the yeasts, sugar fermentations are useful. As a last resort regarding identification there are animal inoculations. Rabbits are killed by intravenous injection of a prescribed dose of *"Monilia" albicans* but not by *M. parapsilosis, M. candidus,* or *M. Krusei.* These four commoner Monilias may also be differentiated with practice by morphology and cultural appearances and fermentation reactions. Benham's papers on the identifications of yeasts are to be recommended. Rats are used for Sporotrichosis, intratesticular injection. Guinea pigs may be used for Actinomyces and yeast like fungi.

Serological studies have been made with fungi but are rarely of practical importance. Monilia vaccines and Trichophytin extract may be useful in treatment especially when the patient shows great sensitization in the form of ids. The commercial houses prepare reliable mold extracts for testing and desensitization. If you should make them yourself, the procedure is similar to that for making tuberculin. Controls must be run first on non-allergic persons, and extreme care must be exercised in testing and treating an allergic patient with them.

Laboratory workers should be warned to avoid inhalation of dry cultures since lung infections have been recorded in this manner with Coccidioides immitis particularly.

VI. *Conclusion.*

In conclusion let me say that fungi are in my opinion an interesting and worthwhile group for laboratory people to know. It is unfortunate that there are so few people properly trained in this specialty and that there are no satisfactory complete textbooks. One should have at hand the several books on mycology and reprints for the special groups. I would also strongly recommend a permanent collection of slides and cultures.

When you find a significant organism and difficult of diagnosis there are a few authorities scattered around the country known principally by their books and papers.

Thank you for your kind attention, and may you have more and better success with the medical mycoses.

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THE FUNCTION OF THE LABORATORY IN THE DIAGNOSIS OF THE BLOOD DYSCRASIAS*

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In almost no other field of medicine is there required for diagnosis such a broad knowledge of laboratory methods, such skill and care in carrying out procedures or such caution in the interpretation of results as is the case in problems of hematology. For these reasons the patient with a blood dyscrasia is never just another uninteresting "case" and the studies carried out in the laboratory on such a patient must never be "routine". Each patient is an individual problem in diagnosis requiring the thorough, painstaking methods and relentless follow-up of the successful detective. The physician is the "G-man", the medical technologist his technical assistant. The correct diagnosis is made only if the information supplied by each is complete and accurate. The physician is treading on dangerous ground when he attempts to diagnose the blood dyscrasias without the full cooperation of the laboratory and even more dangerous ground lies ahead if he will depend entirely on the laboratory and disregard data which may be obtained from a careful examination of the patient. Recognizing the importance of the laboratory as an aid in the diagnosis of diseases of the blood the physician or hospital intending to establish a useful laboratory will realize the necessity of obtaining a skilled technologist and of supplying her with dependable equipment of sufficiently modern design to keep the results up to date.

Personnel of the Laboratory

The responsibility for carrying out the detailed studies required in the hematological laboratory will be assumed by the technician

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who must therefore be skilled in the several technics employed. The qualities necessary in the personality of a good technician and the background of knowledge which she should have before undertaking her technical training may depend on the type of work which she will ultimately do but certain characteristics are important for the success of any technician. She must be intelligent, although not all intelligent young women will develop into good technicians. She must be entirely honest so that she will from the first day in training record the result which she gets whether or not it seems to be a logical one. She must be neat and orderly. She must have sufficient mechanical ability to allow her to learn to fill a blood counting pipette or chamber correctly and easily, to measure accurately with graduated pipette or burette, to weigh accurately and to use colorimeter or microscope skillfully, and she will be far on the road to success if she has a true interest in work of a scientific nature.

Not less important to the value of the laboratory is the chief or director. The character of the work turned out by the laboratory established to serve the practice of one or more physicians privately will be determined largely by the character of the work done by the physician or group of physicians to whom the technician is responsible and to whom she looks for guidance. Technical methods should be selected and interpretation of results made by the physician for whom the work is being done but the technician will at all times see that the equipment is adequate and that the laboratory is in working order. The value and reliability of the laboratory set up for hospital ward or outpatient service, or established as a private business undertaking to which physicians may refer patients or material for study will depend very largely on the ability and training of the director. A laboratory without intimate supervision has little value for any purpose and the laboratory which will be most valuable for the diagnosis of diseases which come under the head of hematology will be supervised by a graduate physician who continues to have clinical contact with patients. The director or chief should be sufficiently familiar with both the clinical and technical phases of the problems encountered in the diagnosis of disturbances of the blood so that data obtained may be properly interpreted and checked as to accuracy. Such a responsible chief will be able not only to recognize errors which may occur through technical difficulties but

his own honesty and sincerity of purpose will insure the confidence of the technician in his ability and will tend to enhance her interest in the problems upon which she is working so that each one will appear to her as an important link in the chain of evidence being sought after so that no procedure becomes one of routine boredom. It is quite true that the laboratory technician should not be expected to make a diagnosis, but she is a human being, interested in her work if she is worth her keep, who will welcome even a brief discussion of the possible clinical application of the results which she has obtained. The technician's value to the laboratory and to the physician under whose supervision she works increases in proportion to her knowledge of the application of her results and this knowledge will be obtained through frequent discussions with her chief. The time spent in such discussions is not time wasted.

The good laboratory director is not a slave driver whose main interest is in rapid turnover of work. He will realize the importance of accuracy—of quality rather than quantity of determinations.

Equipment

Data obtained by a skilled technician in a well supervised laboratory will be of value in proportion to the usefulness and accuracy of the equipment which is supplied and the quality of the chemicals and standard solutions available for use.

Good apparatus is an absolute necessity for a well functioning hematological laboratory. A microscope in good order mechanically, with good magnification must be available for the detailed study of stained blood smears and for doing blood counts. A binocular scope may save eye strain and the resulting fatigue. A satisfactory source of light should always be available. To work for long hours at a microscope with inadequate or too bright a light will cause eye strain and fatigue and will not supply the proper illumination so necessary for recognition of the details of cell structure or inclusions so important in the examination of the blood smear.

Standardized counting chambers, pipettes and hemoglobinometers are essential equipment. We have checked with standardized pipettes the blood counts made with a number of non-standardized ones and found variations as great as 800,000 erythrocytes per cubic milli-

meter above or below the counts obtained with the standardized ones. It is obvious that such a difference in two pipettes were they used for the same patient on consecutive days would present confusing data. The hemoglobinometer must not only be standardized but must show the relationship between percentage reading and the number of grams of hemoglobin per cubic centimeter of blood that this percentage represents. Several satisfactory methods for the determination of the hemoglobin are available and one of these should be chosen as opposed to others in which the results are little if at all more valuable than the Tallquist scale.

The preparation of diluting fluids for use in blood counting and solutions for use in chemical procedures requires some thought and care. Chemicals of satisfactory quality should be selected and measurements carefully made. Stock solutions and diluting fluid should be kept in a cool place, preferably in a refrigerator, and diluting fluids in daily use must be changed frequently in order to keep them free from accumulations of blood cells or growth of yeast.

Dyes used in the preparation of stains should be of good quality. Well prepared Wright's stain may be obtained commercially in some cities but if it is prepared in the laboratory a good quality of dye in proper proportion should be carefully ground in acetone free methyl alcohol, the entire procedure carried out carefully and then the timing for each batch of stain determined and strictly observed in practice. A poorly stained blood smear is difficult to study and the data presented may be inaccurate and misleading.

Standard procedures for each test used should be chosen and once chosen, strictly adhered to. This does not mean that there can be no change in the laboratory procedures but if a change is to be made there should be a period when parallel determinations are run in order that the data obtained by the two methods may be compared. If the change in procedure is planned in the interest of simplification it must be demonstrated that the value of the result is not importantly altered by such a change. This is an obligation which the laboratory has both for its own reputation and in order that the physician using the data will not be confused. A period during which parallel determinations are made will indicate whether or not the newer procedure will be retained or discarded in due course of time.

Data Needed for the Diagnosis of the Blood Dyscrasias

It is not our intention to enumerate or discuss in detail all of the studies which it may be desirable to carry out in a laboratory in order that the various disturbances of the blood system may be differentiated but rather to call attention to certain ones which are particularly important, which are often neglected or which are likely to be inaccurate unless carried out with scrupulous care in the details of technic.

No single laboratory procedure is so important as is the careful study of and intelligent interpretation of the picture present in the stained blood smear. From the stained smear the skilled technologist will learn much about the erythrocytes and their hemoglobin content which will be a check on the accuracy of data obtained by other means, the number and variety of leukocytes in the peripheral blood may be determined with considerable accuracy, the number and character of the platelets will be roughly indicated, certain parasites detected and by special staining the reticulocytes may be enumerated. A description of the picture seen in the stained smear should be complete and accurate because it may be invaluable as an aid toward diagnosis. A statement that the erythrocytes show poikilocytosis and anisocytosis is of little value compared with a detailed description of the form of the cells, their variations in size and the approximate number of cells of the various sizes and shapes seen. Complete absence of platelets or a marked decrease from normal in their numbers with large, atypical forms will suggest a definite disturbance of the blood forming organs with a tendency toward the development of purpura. Unusual or young forms among the leukocytes may be important evidence in the early diagnosis of the leukemias or poisoning from toxic substances such as benzol. The variations which may appear in the stained smear are too numerous to even mention here, but the more smears that one examines carefully the more valuable will be the description recorded.

Hemoglobin results must always be recorded in grams per 100 cc. of blood or in such a manner that this figure may be determined from the percentage. The number of grams represented by 100 per cent varies with the several methods available for hemoglobin determination so that the percentage figure obtained by one method

may not be comparable to that obtained by any other. Hemoglobin determinations are notably difficult to make accurately even with the greatest of care.

A close rival to the inaccuracy of the hemoglobin figures are those of the number of erythrocytes and leukocytes in the blood as counted in many laboratories. Yet in spite of the inaccuracy of all of these figures they are used as the basis for determining the various indices so often included in hematological reports. Enumeration of the erythrocytes and leukocytes of the peripheral blood will approach accuracy only if, among others, the following rules are observed: The ear or finger puncture must be deep enough to allow a rather free flow of blood without the need for considerable pressure near the wound and pipettes should be shaken two or more minutes just before the fluid is run quickly and accurately into the counting chamber where it should stand two minutes before being counted. Pipettes must be dry and clean, diluting fluid reasonably fresh and clean and equipment standardized. These rules seem almost too obvious and simple to need emphasis; yet I know of no figures so frequently incorrect.

Studies of venous blood may add invaluable data for diagnostic purposes. For this use blood is usually withdrawn from a vein at the bend of the elbow and in order that this should not be an ordeal to the patient the technician or physician who is to withdraw the blood must learn to do it skillfully and with a sharp needle. If you frequently miss veins and have to repeat the procedure your technic is poor and you should perfect it or have someone else do the vein-punctures. The blood obtained as quickly as possible after the tourniquet is applied will be run carefully into one tube containing the required amount of oxalate and into a clean dry tube without oxalate. In order to avoid hemolysis a dry syringe and needle are used and the needle is removed from the syringe before allowing the blood to run gently down the side into the tube. To prevent clotting the tube containing oxalate is gently tilted up and down several times. The blood is never shaken and in the plain tube it is not agitated or manipulated in any way until it has been centrifuged and the serum removed for a determination of the icteric index. For this test, and preferably for all, the patient should be

in a fasting state. Even slight hemolysis or clouding of the serum or plasma will cause an inaccurate icteric index reading.

The individual cell volume or mean corpuscular volume is determined from the oxalated blood. Several refinements in technic for this procedure have been introduced apparently in an effort to increase the accuracy of the method. These refinements have introduced graduated tubes for centrifugalization of blood, but which contain smaller amounts than the 10 cc. used in some of the earlier work. The fact is lost sight of, however, that the larger the quantity of blood used the more accurate will be the hematocrit reading and that the point of greatest error is not in the hematocrit reading but in the erythrocyte count. Owing to the changes in technic which have been introduced the readings obtained in one laboratory are not comparable to those of any other so that it is now necessary for each laboratory to decide on one method of procedure, establish normal limits for that method and then continue to use it. The technic which we have used for many years together with our normal figures are described in the chapter concerning laboratory procedures in "Anemia in Practice", by Murphy, W. B. Saunders Company, 1939.

Other tests which may not on first thought be of importance in the hematological laboratory but are often of great importance from a diagnostic point of view may be briefly mentioned. The guaiac test for the presence of occult blood in feces or gastric content is likely to be neglected. To be of value the solution of the gum guaiac must be made up freshly each day and each batch should be tested on blood in order to demonstrate its activity. The result of the test if active solution is used is of great significance in determining the presence or absence of hemorrhage within the gastrointestinal tract. Further evidence of hemorrhage within the gastrointestinal tract may be obtained by the demonstration of a blood non-protein nitrogen level above normal in a patient without evidence of renal disease. Anemia occurs commonly in the patient with myxedema which would be demonstrated by the presence of a low basal metabolic rate. But this frequently overlooked cause for anemia might be suspected first by the finding of a high plasma cholesterol level. Low plasma cholesterol levels are commonly

observed in the presence of severe anemia not associated with myxedema and may be particularly low in the patient with familial hemolytic anemia.

Suggestions for the Technologist's Spare Time

The technician enthusiastic about her work and interested in finding some means for the expression of her artistic talents will find this possible, amusing and valuable. Scientific exhibits are always interesting and often instructive both to the one who prepares them and to at least the more discerning of those who see them exhibited. The following lantern slides illustrate the essential features of blood smears from several of the more commonly encountered blood dyscrasias. These are taken from models originally made as part of an exhibit which we have used at several medical meetings. The models were designed to show the cells in profile as one might see them were it possible to pick them out of the blood and look at them directly in the size that they appear in the microscope.

THE ROLE OF THE MEDICAL TECHNOLOGIST IN THE POST MORTEM INVESTIGATION OF DISEASE*

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Members of the American Society of Medical Technologists:

I desire to express my appreciation of the privilege of appearing before your society. I have chosen as my topic the position of the Medical Technologist in relation to the post mortem study of disease.

At first sight, it would appear to offer nothing more nor less than another chore for the over-worked technician. However, it is my feeling that in many hospital groups the functions of the medical technologist are not sufficiently close to the autopsy table. If one remembers that all laboratory workers are basically concerned with investigation of disease in its manifold aspects, one readily appreciates that while the bulk of our efforts should be directed towards that part concerned with the live patient, nevertheless, a substantial obligation exists in relation to the study of the changes that the disease produces when the case has come to a fatal termination. The psychology of the moment would seem to be that the medical technologist in the average hospital laboratory is more utilitarian than scientific, and it is as much with the desire to stimulate a broader point of view as to the definite function of the technician that I have chosen the above topic as my subject.

Speaking as one whose training is primarily in the field of morphological pathology where the bulk of my efforts are concerned with the gross and microscopic study of the various organ changes secondary to disease processes, I feel that until recently, like many of my brethren, I had been remiss in utilizing other tools in the laboratory. The hospital pathologist is very prone to become routin-

* *Read before the Eighth Annual Convention of the American Society of Medical Technologists, New York City, June, 1940.*

ized in his work. Most of us in the course of our autopsy investigations stick to a beaten path. Unfortunately, perhaps many of us are too individualistic and have failed to appreciate the possible value in widening our outlook by the means of using more varied tools with which to conduct our investigations. I mean by that that the average pathologist performs the autopsy, describes the gross findings, and prepares histological sections on which he is prepared in most instances to base his final conclusion. Until relatively recently, and largely because of the fact that because at the time of his initial training in the field, the collateral branches of laboratory investigation had not been as highly developed as they are now, the pathologist took little thought of the help that he could obtain from studies in such fields as chemistry, hematology, bacteriology, and the like. Now, however, with the widening scope of the laboratory, with the development of a larger body of specialized knowledge in the hands of trained and specialized technical assistants, a new and wider field has suddenly opened up to the hospital pathologist in the post mortem investigation of disease.

We all know the prime value of an autopsy report in relation to the education of the staff members through the medium of clinical conferences and discussions. We know that nowadays the clinical data in most well-organized hospitals represents in the last analysis a vast assemblage of facts drawn from the various specialized branches of clinical and laboratory medicine. We must now come to appreciate that in order to test the accuracy of many of these clinical investigations in fatal cases that come to autopsy, we must proceed to the gathering of as much material over as wide a field as has been done in the clinical study; in other words, we must be prepared to match autopsy evidence with clinical evidence, to compare them and to see where they lead us in the final analysis. The day is rapidly passing where the pathologist can afford to dismiss lightly the questions of the clinicians as to the nature of the infective agent in a fatal condition in which infection plays the major role, or to blood chemical changes that are expected to exist in the light of a badly damaged kidney found at autopsy, to take two simple examples. With these facts in mind, we therefore are looking more and more to the medical technologist to enter into a cooperative investigation of post mortem material.

Dealing first with the bacteriological studies at the post mortem table, there can be no question that their importance is great. I am quite familiar with many of the controversial points as to the relative merits of post mortem bacteriology, but it seems to me that many of the discussers have centered too much on the validity of the finding of this or that organism, as to whether it was or was not an ante mortem invader, losing sight of the basic method of approach in the study of disease in general, namely, the gathering of shreds of evidence which by themselves have little weight, but which when taken in conjunction with other evidential material, are tantamount to confirmatory evidence. A simple example, for instance, would be the finding in the post mortem blood culture of an organism like the colon bacillus. If such a patient had lacked any evidence of infection during life and fails to show any structural changes in the organ that could be associated with the disease, then undoubtedly the organism found at post mortem must be a secondary invader or contaminant. On the other hand, if during life the patient shows evidence of infection, and if the ante mortem blood cultures fail to recover the invading organism, and if at autopsy one recovers, say from the culture of the heart valves which are the seat of ulceration and thrombus formation an organism, say a hemolytic streptococcus, then such post mortem bacteriological evidence must of necessity carry great weight in our final conclusion. For this reason, therefore, if the pathologist has reason to suspect at the autopsy table that the changes observed in the organs might be the result of an infective process, then it is obligatory that he study post mortem cultures on the heart's blood and the spleen, and possibly other organs, depending on the individual problem. Furthermore, if during life positive blood cultures have been obtained in the course of an acute infection, it is equally important to attempt to confirm and to complete the investigation by culturing the blood and the spleen and perhaps other organs, to see if the same organism can be recovered as was found during life.

There is one particular field of post mortem pathology in which to my mind the assistance of the bacteriologist is a prime requisite for a correct pathological diagnosis, namely, in the field of intestinal disease, especially where ulceration of the intestinal tract is involved. Any standard textbook in pathology dealing with intestinal ulcera-

tion describes the location and shape of these ulcers as a means of diagnosing the disease. After very little experience, one wonders how sound such an approach is. One feels that while such leads are of value and while early pathologists, devoid of bacteriological assistance had frequently to rely on no other evidence than this, yet now with the more accurate bacteriological identification of intestinal organisms, it is my feeling that the pathologist should refrain from diagnosing the etiology of ulcerative lesions in the intestinal tract on their morphological appearance alone. I am reminded of a recent example at the hands of one of my colleagues who autopsied a child complaining of diarrhea, with pea-soup stools. At autopsy, localized ulcerations were found in the Peyer's patches of the small intestine, the long axes of the ulcers being parallel to that of the body. Those of you who are familiar with the pathology of typhoid fever will immediately recognize such a description as being typical of typhoid ulceration. On the strength of this data, he made a presumptive autopsy diagnosis of typhoid fever. Microscopic sections of the ulcers were studied, and the cellular response in the areas of ulceration was also compatible with the diagnosis of typhoid fever. However, a culture of the intestinal material failed to show typhoid bacilli but turned up instead a Flexner strain of dysentery bacillus. An experience of this sort, therefore, prompts the cautious pathologist to refrain from making an etiological diagnosis in these intestinal conditions until the bacteriologist has identified the organism.

Very frequently, too, and especially perhaps in medico-legal cases where the demand for a connected chain of evidence is so great, the technician in bacteriology offers great assistance. A recent case will help to illustrate this point. A 30-year-old woman, with fever and suggestive stiffness of the neck, showed repeatedly positive blood cultures of staphylococcus aureus. On her death bed, she confessed that she had been subject to an abortion three weeks previously, and at autopsy she showed abscesses in the lung, a necrotic lesion of the tricuspid valves of the heart, a purulent infection of the substance of the kidney, and what is most important, a mass of adherent tissue in the uterine cavity, the surface of which was distinctly necrotic. The post mortem culture of the spleen demonstrated staphylococcus aureus; the culture of the necrotic

material in the uterus demonstrated the same organism, and histological studies of the adherent uterine mass showed the presence of placental tissue. By means of the post mortem bacteriological studies, the chain of evidence was thus complete.

In summary, then, it is obligatory on the part of the pathologist nowadays to keep in mind the importance of gathering as much bacteriological data from the autopsy as is indicated in the individual case. I might have stated earlier that for the pathologist to do this, he must be sufficiently acquainted with the clinical story of the patient before he starts the autopsy. By so doing, he will develop leads in his mind which he will follow through the medium of the bacteriological approach. I cannot resist the temptation to pause for a moment and digress on the positive evil of performing the autopsy without scanning the clinical chart. To my mind, it is as if one proceeds to embark on a sea trip on a rocky coast without a navigation chart.

Dealing now with the value of post mortem studies of the blood, one immediately recognizes its importance in connection with the study of the anemias and leukemias. The rapid progress we have made in the proper appreciation of hematopoietic disease has been assisted considerably by careful studies on bone marrow preparations, prepared post mortem. No hematological case has been completely investigated unless the pathologist obtains representative samples of marrow from various of the bones of the body, and prepares fresh smears to be studied later by Wright's or Giemsa's method of staining. Histological preparations of decalcified bone marrow have their place, but they are considerably supplemented by a study of fresh marrow material obtained at the autopsy table. One is tempted to feel that the use of the present bone marrow biopsy in the clinical or ante mortem study of blood diseases is a direct outgrowth and a tribute to the merits of the post mortem marrow studies that preceded this newer method of investigation.

Another application of the study of the blood in post mortem investigation is its use in medico-legal fields. Time does not permit and there is no real need to a group that is thoroughly familiar with the subject, to labor this point. However, by identification of suspected material as human blood, and by the proper grouping of

such blood, it has been possible in recent years to solve many crimes. Many of you have noticed the recent exhibits of Dr. Weiner dealing with this matter. It might be of interest to remark, too, that apart from the scientific interest of such medico-legal work, the positive identification by such blood grouping often has a psychological effect on a suspect, leading him into a confession of his crime because of his instinctive fear and respect for exact scientific evidence.

Turning now to the field of blood chemistry, it is my opinion that post mortem studies of the blood can be of distinct use in the investigation of disease, provided they are cautiously interpreted in the light of pre-existing clinical and laboratory evidence. For the past few years, Mrs. Pray and I, at Meadowbrook Hospital, have been interested in this problem and have collected material from nearly 100 cases. There are certain disturbing findings that prevent us from claiming too close a correlation between the ante mortem and post mortem blood values, but nevertheless we feel that post mortem blood chemistry determinations are of value. To cite a simple case, a patient is brought into the hospital in deep coma and before any laboratory studies can be made, the patient dies. The autopsy fails to reveal any gross changes other than congestion in the organs studied. A post mortem blood sample on analysis reveals a marked hyperglycemia. The urine removed from the bladder at the same time reveals a 4 plus sugar. The evidence, therefore, would seem complete that this patient died in diabetic coma.

The use of post mortem blood chemical determinations is of value taken in correlation with structural changes observed in kidney disease. We all of us are familiar with the aged patient who on admission to the hospital receives the routine blood chemical examination, and who frequently dies as the result of, say, intercurrent infection. On reviewing the chart prior to autopsy, one notices that the patient was drowsy and perhaps comatose during the last week or so of life. On examining the kidneys, one perhaps finds sufficiently extensive destruction of renal tissue associated with a recent fibrinous pericarditis to raise the question in one's mind as to the possibility of a terminal uremic process. Post mortem blood withdrawn at this time, when subjected to chemical analysis

will frequently supply the added link that makes the chain of evidence secure. In this connection, it must be remembered that it was not the increase of the urea by itself in the post mortem blood that would warrant the diagnosis of uremia, because, as we know, blood urea can be increased in a variety of conditions; it was rather the presence of a heightened urea value in the face of kidney and pericardial pathology that prompted one to use the urea determination as evidence of terminal kidney insufficiency and uremia.

There is another blood determination that might offer help in post mortem investigation, namely, the determination of the specific gravity of the blood by means of the falling drop method. As most of you know, there has been a recent renewed activity in the study of the blood by this method in states of shock and hemorrhage, it being felt that in many instances it is possible to determine the oncoming development of shock by means of blood gravity changes. You have heard this morning from Dr. Drew as to the use of this method in the study of surgical conditions. We have insufficient evidence at the moment to justify our expectations, but it would appear to be of some value, even though it might be limited, in the study of certain cases, especially traumatic cases where one attempts to make a distinction as to whether death is due to hemorrhage or shock. We are at present conducting studies to this end in the Medical Examiner's Office of Nassau County, and hope to report on the results at some future date.

Another great adjunct to post mortem studies is the contribution in the field of toxicology that the technician in chemistry can provide. This is especially true again in medico-legal investigations where the recovery and identification and frequently the quantitative determination of the lethal drug is of vital importance. Unfortunately, few poisons produce specific gross or histological changes in the various organs of the body so as to permit of their recognition by inference. In fact, as many of you know, almost all the changes that the pathologist notices in cases of poisoning are congestion of the various organs. For this reason, he must be particularly alert as to the possibility of poisons, and be prepared to follow seemingly unimportant leads into the field of toxicology. To illustrate this, let me cite briefly a recent case. A substantial, middle-class merchant

was found dead one morning at the foot of his cellar stairs. It appeared from the description given by the family that, as had been his custom, he was on his way to attend to the furnace, and it was suggested that he had suffered a heart attack and had fallen downstairs. At autopsy, because of his age and probably other factors, there were changes in his coronary vessels that could have substantiated a diagnosis of sudden death from heart disease. However, on examination of his stomach, one could detect a distinct ammoniacal odor. On the strength of this lead, the viscera was subjected to toxicological examination, and revealed the presence of quantities of cyanide, so that what at first might have been considered as a sudden cardiac death was established to be one of suicide. On subsequent investigation, it was learned that the man was in severe financial difficulties.

In connection with toxicological determinations, those of you who work in laboratories where the pathologist handles medico-legal material know the frequency with which examinations of the brain are done to determine the presence of alcohol. There is abundant evidence to show that a large number of fatal automobile accidents involving deaths of both drivers and pedestrians are associated with intoxication, so that it is highly necessary at this time to do quantitative alcohol determinations in all such fatal cases.

There is another chemical application to post mortem work, namely, in the study of drowning. Because of our geographical location, we handle a relatively large number of cases, especially at this time of year. A distinct problem has presented itself to us, namely, the determination of the cause of death in individuals well past middle life who die in the water at the various beaches. Without attempting to deal with the finer differences, a practical example shows the importance to the accuracy of the investigation. As many of you know, it is still a common occurrence to have these cases declared by coroners and even diagnosed by physicians as—death due to heart disease. If one depended only on the autopsy findings of the changes in the heart of people in this age group, then these changes are certainly compatible with such a diagnosis. However, a routine chemical examination of such a group of cases frequently reveals that the cause of death is drowning. As most of you know,

Goettler of Bellevue many years ago developed a test which has since enjoyed wide acceptance, namely, the chloride determination of blood in the right and left chambers of the heart. It has been found that if one drowns in salt water, then the chloride content in the left chamber of the heart is higher than the right. If one drowns in fresh water, the reverse is the case. These facts are based on the assumption that the foramen ovale, the communication between the right and the left heart, is closed. It is possible to cite many cases where, following the gross inspection of the heart, with a chemical determination, it has been possible to demonstrate beyond question that death was due to drowning. There are certain interesting implications in these findings. In the first place, death from drowning is regarded as accidental. A death from cardiac disease is a natural one. As you know, many insurance policies carry a double indemnity insurance clause in case of death by accident. It therefore becomes extremely important in the protection of the interests of the deceased's relatives that a clear decision be made on this matter. Let me cite two cases to illustrate the value. Case 1 deals with a 67-year-old white male who went swimming in fresh water one Sunday morning. He was seen to stop swimming, and on being rescued, attempts at resuscitation failed. Changes in his coronary vessels and myocardium were present. Blood determination failed to reveal any significant difference in the chloride values in the right and left side of the heart. This case was considered as death from cardiac disease. Case 2 deals with a middle aged man who was known to have heart disease and who gets in difficulties while swimming. On being taken ashore, he is pronounced dead after artificial respiration has been persisted in for some time. At autopsy, adequate pathology is found in the coronaries and myocardium. Chemical examination of the blood reveals a chloride difference to suggest death by drowning. Irrespective of whether a heart attack did or did not precipitate the sequence of events that finally led to his drowning, it is obvious that his death is due to an accident. This carries with it the double indemnity to his family, as a result of a more complete autopsy investigation in which a chemical method is used.

In connection with death by drowning, it is interesting to mention a recent case in which an airplane crash occurred over Long

Island Sound. Two of the three persons involved in the accident died shortly after being recovered from the water and showed extensive traumatic injury. The third case was not recovered until some days later. This man happened to be the pilot of the machine, and at autopsy showed minor trauma, such as fractures of the ribs. Chemical examination revealed a high chloride difference in favor of the left heart, so that death was established as due to drowning in this instance, and not as in the previous two cases, to trauma.

It would seem then from a rather sketchy presentation of the various functions of the medical technologist in relation to post mortem investigation of disease that the investigation of the laboratory problem is primarily a joint procedure. By such a method, the pathologist and his assistant will thus obtain data which lends itself to more logical correlation with the antecedent clinical evidence, and in so doing will provide us with new material on which to base an increase of knowledge in the study of disease processes. It is by such general methods that medicine has progressed, and I can think of nothing that offers a sounder prediction for the future of post mortem investigation of disease than the valuable aid that the medical technologist now provides in this connection.

A SIMPLE METHOD FOR TESTING THE SENSITIVITY OF COLLOIDAL GOLD SOLUTIONS

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It is known that precipitation of colloidal gold depends upon the albumin-globulin ratio in spinal fluid. The albumin has a retarding action while globulin tends to activate precipitation.

The above principle is utilized by employing the use of a solution of edestin, a vegetable globulin from hemp seed, first used for this purpose by Kriedler and Small[1] and later by Williams[2].

Edestin can be accurately weighed and solutions of definite strengths made. Since it is insoluble in water or weak salt solutions, 0.18% Hydrochloric acid is used as the solvent. This amount of HCl does not affect the pH of the colloidal gold solution notably and in the case of Lange's Colloidal Gold, does not affect the final titration.

It has been found that a 1 to 2000 solution used in the following manner will give a typical "paretic" type of reaction (5555421000).

Method

Set up the regular number of tubes used in the test and pipette 0.9 c.c. of 0.4% sodium chloride in the first tube and 0.5 c.c. in each of the others. Add 0.1 c.c. of the edestin solution to first tube, mix and transfer 0.5 c.c. to second, mix and carry out procedure in the usual manner. Use as controls, one tube containing 0.5 c.c. of 0.4% sodium chloride and one tube containing 0.85 c.c. of 1% NaCl. (0.85 c.c. of 1% NaCl should precipitate 2.5 c.c. of colloidal gold in 2 hours to a "5"). Add 2.5 c.c. of colloidal gold solution to all tubes.

The above method may be employed in the final titration of

Lange's Colloidal Gold Solution and may also be used to adjust the solution according to the method outlined in Bray's "Synopsis of Clinical Laboratory Methods."[3]

Summary and Conclusions

1. A standard solution of edestin which precipitates colloidal gold in a manner which simulates "paretic" spinal fluid is described.

2. A simple and practical method for using this standard globulin solution to test the sensitivity of colloidal gold solutions is presented.

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BOOK REVIEW

RADIOLOGIC PHYSICS by Charles Weyl, S. Reid Warren and Dallet B. O'Neill, Moore School X-ray Laboratory, Moore School of Electrical Engineering, University of Pennsylvania with Foreword by Eugene P. Pendergrass, M.D., Director of the Department of Radiology, University of Pennsylvania. Charles C. Thomas, Publishers, Springfield, Illinois, 1941. Cloth, 459 pages with index. Price $5.50.

The book is divided into two sections; the first two-hundred pages are devoted to elementary electrical engineering and elementary physics. The rest of the book is devoted to radiological physics per se.

In the first two chapters of the first section, the authors review some of the most elementary concepts of electricity and magnetism, and physical mechanics. In so doing, they lay a groundwork for what follows in the next five chapters (150 pages) which take the reader through some quantitative ideas of electrical circuits to a sound basic idea of why and how common electro-medical machinery from the electrocardiograph to the Van de Graff generator really works.

The temerity of the authors in tackling some of the subject matter of this first part is remarkable, and their skill in executing it commendable. Many of us have in our own minds a pedagogical gulf, planted there by long forgotten teachers, between the fields of physics and chemistry. These authors, by their discussion of atoms and molecules, energy levels and electrochemistry, help us to remember that in actual fact, the gap never existed. Some parts of the first section contain rather terrifying mathematical formulae, which on inspection, prove to be only the simplest algebra and arithmetic. The authors have succeeded in showing how such concepts as the relativity equation for change in mass are applied, and why they are important. Some points, such as the consideration of the power factor, could easily have been left out. By so doing, the authors could have freed the book of a lot of square-root signs and made it more saleable. By refusing to do so, they have supplied a simple and lucid explanation to those who wish it, while those who

have no interest in power factors can easily skip this part and in the next few pages find an excellent description of the fundamentals upon which electrical measuring instruments work.

The second section (page 205, et. seq.) applies the basic problems to the theory and practice of radiology. The section starts off with a very straight-forward consideration of the different types of radiation, their mode of origin, and their interaction with matter. It goes on through strictly practical concepts of x-ray and gamma ray intensity measurements, depth dose, surface dose and tissue dose. Most all of this section is spent on therapy. The main text ends with two chapters in which the important factors governing definition and contrast in roentgenography and fluoroscopy are covered. Here, as elsewhere, throughout the book, the authors develop the principles and then show their application to actual problems. A good text-book job is done of explaining the operation and application of helpful instruments such as the densitometer and the Bucky diaphragm.

The style of the book is analytical and generally excellent. At times, however, the authors have been forced to condense into a few pages the material that would normally take a semester course of lectures. The result is a paragraph here and there which leaves the reader "on the ropes." Also, they are sometimes on the horns of a common dilemma; faced with the necessity of writing an explanation lucid enough for the practical radiologist without leaving an opening through which they can be sniped by the academician. This has lead to some rather involved explanations.

It must be remembered that this is a textbook, suitable either for a survey course or a self-conducted review. Basic principles rather than authoritative statements are given, particularly of technological matters such as high vacuum pumps. For those who would study further, a bibliography is included.

The most obvious criticism is that the explanations in the book are too superficial for the physicist and too complicated for the radiologist. It is probably more truthful to say that the authors have done an excellent job of gap-bridging.

K. E. Corrigan.

NEWS AND ANNOUNCEMENTS

MINUTES OF THE 1941 SESSION

House of Delegates

Cleveland, Ohio, June 3, 1941

The House of Delegates of the American Society of Medical Technologists met in executive session at 3:00 p. m. Tuesday, June 2, 1941. Thirty-three delegates and officers were present representing 21 states. The meeting was called to order by the president, Miss Henrietta Lyle. The minutes of last year's meeting were read and approved. Miss Tate, the treasurer, was called upon to give the financial report for the year. A motion was made by Mr. Flannary that only a summary of the report be read. Motion carried. The report of the program committee, the scientific exhibit committee, local arrangements committee, and advisory board were given and accepted. The Board of Directors' report was read by Miss Lyle. Miss Claussen moved that the report of the Board of Directors be printed in its entirety in the Journal of the American Society of Medical Technologists in order that all of the members of the Society might be acquainted with the activities of the Board of Directors. Motion carried.

Voting on amendments to the By-Laws was next taken up. Mr. Flannary moved that discussion be limited to three minutes for each article of the By-Laws discussed. Motion carried. Seven proposed amendments to the By-Laws were voted upon as follows:

Article III, Section 5, Supplement—Nominations may also be made from the floor after the acceptance of the report of the Nominating Committee. This supplementary change was accepted by the House of Delegates. All other proposed amendments to the By-Laws lost; vote taken by acclamation.

Mr. Conlin moved that the House of Delegates express an opinion that the Board of Directors invest $200.00 in defense bonds. Motion carried.

It was then moved by Miss Leisman that the Society adopt a suitable emblem to be used on automobiles and that this emblem be available to all A. S. C. P. registered medical technologists. Motion carried.

A discussion of the use of visual education aids and materials to be collected and distributed by the Registry followed. Miss Teeple moved that the Society accept any offer of program materials that the Board of Registry might offer us for distribution by our Society. Motion carried.

Mr. Conlin moved that we present a suggestion to the Board of Registry that they publish an alphabetical list of registrants as well as by states. Motion carried unanimously.

Miss Stanley moved that the resolution presented to the American Red Cross, drawn up by the Board of Directors, be accepted as written and presented to the bodies named within. Motion carried.

It was moved by Mr. Fitzgerald that a sum of $500.00 be appropriated by the Society for the publication of the Journal. Motion carried.

The election of officers for the coming year was the next order of business. The nominating committee for next year was first voted upon. Vern Flannary, Ann Snow and Lucille Wallace were elected by acclamation. It was moved by Miss Zoll that the nominating committee for next year be composed of only three members. Motion carried.

Miss Teeple, Miss Tom and Miss Clark were appointed as tellers by the president. The result of the election of officers was as follows:

President-Elect, Evelyn Jardine; Recording Secretary, Mary B. Leisman; Advisory Board, Henrietta Lyle; Board of Directors, Sister M. Stella O'Sullivan, Frances Pennypacker.

A Resolutions Committee consisting of Nylah Tom, Marie Clark and Katheryn Teeple was appointed by the president. Meeting adjourned at 6:00 p. m.

IDA LUCILLE WALLACE,
Acting Secretary.

REPORT OF THE CHAIRMAN OF BOARD OF DIRECTORS FOR YEAR 1940-1941

On receipt of a letter July 29, 1940, referred by Mrs. Anna Scott, Registrar, Registry of Medical Technologists, A.S.C.P., from Borghild Sausen, Secretary New York State Association of Occupational Therapists, concerning the attitude of the medical technologists towards the enrollment of medical technologists without commissioned rank by the American Red Cross for service in time of emergency, the Board of Directors approved a resolution to be ratified by the A. S. M. T. at its next assembly. The resolution is enclosed with this report and copies have been sent to the designated places. The resolution was also published in the Journal.

A questionnaire was sent to the Board of Directors January 5, 1941, asking for the opinions of the members of the Board on points of policy. The Board did not think a mid-year meeting necessary.

A letter was mailed January 26, 1941, to the members of the Board discussing the problem of registrants of the Board of Registry, A.S.C.P., who have failed to reregister or have been dropped from the rolls of the registry and who have continued to be listed as members of the A. S. M. T. The result was a preparation of an addition to Article 1 of the By-Laws to be voted on by the House of Delegates. Additional proposed changes to the By-Laws were discussed and ordered to be presented to the membership of the Society.

Letters were written to Dr. Hillkowitz and Mrs. Scott, the retiring chairman of the Board of Registry and Registrar, to express our appreciation of work during the past years in behalf of our profession. Also, letters of congratulation and offers of cooperation were extended to their successors, Dr. Montgomery and Miss Swenson.

Routine appointments were made as well as the appointment of Miss Eleanor Siekowitch of Moose Jaw, Sask., Canada, to act as counsellor for Canada. Routine Society expenditures were approved.

The audits of the Executive Secretary and Editor of the American Journal of Medical Technology were authorized. They show

membership, as of May 12, 1941, to be 563 old members and 72 new members in good standing with 109 old members with 1940-1941 dues unpaid. Only 11 members have been actually lost because of death or voluntary severance of relations with our organization. There are 27 applications for membership pending, filing fees have been paid but not dues for 1940-1941. There were five state societies who applied for charters and five who have renewed charters for affiliation. One additional charter, taken out in May, 1940, was included in the audit for last year and should be applied to the number of charters for this year, making the total of affiliated state groups 11. A total of $2623.77 was forwarded to treasurer with a cash balance held in executive office of $43. The report of the audit of the American Journal of Medical Technology for the year ending April 30 is also enclosed. Receipts of $1,855.25 and disbursements of $1,807.63 were listed. Cash balance on hand April 30, 1941, was $286.83.

The audit of the treasury was also authorized and report will be given by the treasurer.

The president and president-elect were members of a committee of Medical Technologists which were to meet with the Board of Registry to present the technicians' angle on current problems of mutual interest. The president attended this meeting held May 27, 1941.

AGENDA

Meeting of the Board of Registry with the Advisory Committee of Medical Technologists Wednesday, May 28, 1941, Hotel Cleveland

1. Consideration of methods whereby the Board of Registry can take part in the betterment of the economic and professional status of the Medical Technologist.
2. Discussion of what state groups of Medical Technologists can do for their own advancement, especially through the assistance of the national society.
3. Consideration of what the American Society of Medical Technologists should be able to do for city, county, district, and state groups.
4. Attitude of state groups toward state licensure and labor unions.

LAWRENCE O. RAY, M.T.
President A.S.M.T., 1941-1942

EVELYN N. JARDINE, M.T.
President-Elect

5. Attitude of registered Medical Technologists toward the Red Bank organization ("The American Medical Technologists").

6. Opinion of Medical Technologists concerning the jewelry now distributed by the Registry. Consideration of samples which have been prepared.

7. Discussion of "Essentials" proposed as a result of the meeting with the Council on Medical Education of the American Medical Association.

8. Discussion of the desirability of conducting special examinations for Medical Technologists whose training has been concentrated on one phase of the work.

9. Discussion of ethics of Medical Technologists.

Topic 1 seemed to add up to the following: the Board of Registry has been active in contacting various registries for employment of medical technologists and have secured the cooperation of these registries in placing registered medical technologists in positions of preference. As there has been a greater demand for registered technicians, the trend is toward better conditions and higher salaries in the United States as a whole. In order to get the direct results of these trends a survey of information now at hand is being contemplated. The members of the Board of Registry also suggested a plan whereby sets of slides, prepared by commercial houses on subjects of interest to technicians and valuable as program material, might be started. The Registry is willing to start this movement and later turn it over to our Society for the distribution to those who want it and for our development of the matter.

Topics 2 and 3 were discussed together by our president who gave a summary of the report of the Education Committee for 1939-1940 as the basis of her remarks. The support of various departments of the A. S. M. T. was assured to those in need of assistance in working out plans for organization of future groups (local) of technologists and assistance with their programs, if advice is requested.

Topic 4, dealing with state licensure and labor unions showed a variation in opinions in regard to licensure, pointing out the various types and the advantages and disadvantages. The majority did not favor state licensure as has been attempted in many instances with-

out success. There was a definite agreement about opposing labor union type of organizations. We are a profession and not a trade and must continue on that plane.

Topic 5—The opinions were favoring continual education of the public and medical profession as to our objects and aims in order to offset the Red Bank Organization (A.M.T.'s).

Topic 6—As there was a desire to change the manufacturer in the making of the jewelry for the Registry, samples were considered. It was decided to keep the design which was practically the same as the one now employed with the exception that the new one will be a little more clear cut.

Topic 7 was based on the report published in the A.M.A. in a recent issue on the Essentials for training Technologists and the recognized types of schools. This can be found in the Education number of the Journal of the A.M.A.

Topic 8—There were many opinions about the desirability of conducting special examinations for medical technologists whose training has been concentrated on one phase of laboratory work only. The discussion took up all angles. The conclusion was a further study of the problems.

Topic 9—The code of ethics as outlined in the leaflet put out by the Registry was discussed. Some criticism has been made about the wording but the opinion was to keep it the same as it has been.

The technical supplement was also discussed with suggestions for the future with other constructive criticism.

The great demand for Technologists who are registered was also discussed. There is a shortage because of our National Preparedness Program and establishment of training camps as well as increased interest in qualified persons in both institutional and office positions.

The suggestion, which had previously been made, to have the medical technologists use M.T. (A.S.C.P.) instead of the M.T. alone was discussed. In using the A.S.C.P. designation after the other letters, it was pointed out that we would not be confused with other groups using the same initials and having different standards than we have.

HENRIETTA M. LYLE,
Chairman Board of Directors.

June 3, 1941.

Photograph taken at Annual Banquet

AWARDS

Ninth Annual Convention of American Society of Medical Technologists, Cleveland, Ohio

1st Award—Gold Medal (Scientific Paper)
Marguerite Lukens, Philadelphia, Pa.

2nd Award—Silver Medal (Scientific Paper)
Sr. M. Antonia, Lexington, Ky.

3rd Award—Bronze Medal (Scientific Paper)
Sr. M. Alcuin, Duluth, Minn.

Colorado

The Sixth Annual Convention of the Colorado Society of Medical Technologists was held May 24, 1941, at the Cosmopolitan Hotel, Denver, Colorado. The following program was presented:

Registration.

Installation of exhibits.

Round Table Discussion—Elizabeth O'Toole, M.T., retiring president C. S. M. T., assisted by Eleanor Meek, M.T., president-elect.

Papers by Members—"Blood Studies on Children," Aldula Johnson, M.T., Denver. "Some Notes on Coccidioidal Granuloma," Elizabeth O'Toole, M.T., Denver. "General Bacteriological Dissociation," Pauline Bigelow, M.T., Denver. "Biologic and Chemical Studies of the Gonococcus with Reference to Its Dissociative Variations," Mary Simeonoff, M.T., Denver.

Luncheon.

Opening Address—E. R. Mugrage, M.D., Denver-sponsor of C. S. M. T. "Mycology and Parasitology," John J. Andujar, M.D., Fort Worth, Texas (Guest Speaker). "Prothrombin Determination," William A. H. Rettberg, M.D., Denver.

Exhibits—"Microbial Finger Prints," Severance Burrage, M.D., Denver. "Methods for the Determination of Some Metals Which Are Industrial Hazards," Leota Pekrul, Department of Chemistry, University of Colorado.

Annual Banquet celebrating Tenth Anniversary of the Colorado Society of Medical Technologists.

Officers for the ensuing year are as follows: President, Eleanor Meek, M.T.; Vice-President, Aldula Johnson, M.T.; Recording Secretary, Philippa Baldwin, M.T.; Corresponding Secretary, Gladys Geraghty, M.T.; Treasurer, La Nelle Lallier, M.T.

Nebraska

The annual spring meeting of the Nebraska Society of Medical Technologists was held Saturday, April 26, 1941, in the Cornhusker Hotel, Lincoln, Nebr.

Program—"The First Diabetic Camp in Nebraska," by Dr. L. F. Rogers, Lincoln, Nebr. "Elliptical Cells," by Helen Wyandt Reihart, M.T., University of Nebraska, Omaha. Taken from her article which appeared in "Genetics," March, 1941, ""Oval Blood Cells in Human Subjects Tested for Linkage with Taste for PTC, Mid-Digtal Hair Color, A-B Agglutinogens, and Sex." Co-author, Barbara S. Burks, Carnegie Institution of Washington.

"Selective Media for the Differentiation of Bacteria," by Dr. K. H. Lewis, Assistant Professor Dept. of Bacteriology, University of Nebraska, Lincoln.

"Serology—Its Values and Worries," Round Table Discussion, led by Florence Tucker, M.T., Bryan Memorial Hospital, Lincoln, Nebr.

"Inherited Body Characteristics," by Dr. David D. Whitney, Professor and Chairman, Zoology Dept., University of Nebraska, Lincoln.

The "Registry Exhibit" was shown at both the Medical Technologist meeting and at the Nebraska State Medical meeting held at the Cornhusker Hotel, May 5, 6, 7, 8.

The following are the officers elected April 26, 1941: President, Gertrude Ebers Hughes, Madison, Nebraska; Vice-President and Program Chairman, Ramona C. Forbes, 2411 So. 23 St., Lincoln, Nebr.; President-Elect, Ida Carr Blore, 303 So. 28 St., Lincoln, Nebr.; Secretary-Treasurer, Ruth ErDena Pohle, 352 No. 41 St., Omaha, Nebr.; 5th Council Member and Membership Chairman, Helen Catherine Hartnett, 1229 Harrison Ave., Lincoln, Nebr.

Texas

The Texas Society of Medical Technologists held its annual convention at the Blackstone Hotel in Ft. Worth, May 10, 11, and 12, just prior to the meeting of the Texas Medical Society, in the same city.

The Society was highly honored by having Dr. James B. McNaught, of the Leland Stanford University School of Medicine, San Francisco, as well as the following speakers from our own state: Dr. Merton Minter, San Antonio; Dr. A. K. Doss, Dr. K. H. Beall, Dr. May Owen, and Dr. J. J. Andujar, of Ft. Worth; Dr. J. L. Goforth and Dr. Arthur G. Schoch, of Dallas, Dr. A. H. Braden, Houston; Dr. N. D. Buie, President Elect of the Texas Medical Society, Marlin; Dr. McDonald Fulton and Dr. H. C. Tidwell, of the Baylor University College of Medicine, Dallas; Mr. Charles E. Langford, of the University of Texas School of Medicine, Galveston; Dr. J. V. Irons, Mrs. Claryce Pitts, and Mr. W. E. Ragsdale, of the State Health Department, and papers by Mr. Jack Aaron, Camp Hulen, Texas.

The following officers were elected for the coming year: Claryce Pitts, President, Austin; Will Ann Staude, President Elect, Ft. Worth; Florence S. Moore, Vice President, Houston; Ruth Guy, Secretary, Abilene; Margaret Davis, Treasurer, Dallas; and a Board of Directors consisting of Paul Lea, Lubbock; N. Manoushagian, Wichita Falls; Mary Julia Allen, Dallas; Lois Parks Byler, El Paso; Hedwig Schoenemann, San Antonio; and Elizabeth Frank, Galveston. Nylah Tom, immediate past president, was elected delegate to the convention of the American Society of Medical Technologists with Claryce Pitts, president. Rose Matthaei, Houston, and Florence Petty, Rusk, were elected alternate delegates.

The 1942 Convention City will be Corpus Christi.

Wisconsin

The Wisconsin Association of Medical Technologists were guests of the La Crosse district at their sixth annual convention which was held in the lecture hall of St. Ann's Hospital, La Crosse, on May 17, 1941. There were 43 medical technologists from throughout the state present.

Dr. W. E. Bayley, Pathologist at St. Francis Hospital, La Crosse, conducted a Round Table Conference which was followed by short discussions and demonstrations on various laboratory procedures by the medical technologists. Dr. Delos F. Doyle, La Crosse, presented case histories and interesting facts about Acute Pancreatitis. Dr. G. G. Stilwell, Mayo Clinic, Rochester, spoke on the examination of cerebro-spinal fluid in the diagnosis of disease.